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ABSTRACT

Where research activities operate under "fixed" budgetary and resource conditions, allocations of funds must be carefully planned for effective program implementation. Although relatively little information is available on how small research units could use the principles of programed budgeting, a technique for ascertaining program operating costs is essential to these units. A modified PERT model has been proposed for providing research management with estimates of project costs, staff involvement time, lag times, resource allocations, and budgetary surpluses. This technique, with refinements in estimates of activity time, appears capable of providing research management with a tool for making practical estimates of budgetary and resource allocations. (Author)

PROGRAM BUDGETING MODEL FOR SMALL RESEARCH UNITS

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PROGRAM BUDGETING MODEL FOR SMALL RESEARCH UNITS

By Edward K. Brown

Most small research units operate on relatively fixed budgets; where additional expenditures caused by unexpected strains on the system result in the diminution of services to evaluation activities. The effects of these constraints upon the fixed resources of the unit are reflected in the depth to which research activities may be conducted and, consequently, in the quality of its reports. In order to minimize the effects of such occurrances on the operations of small research units, special managements techniques, which would assist management in making long range decisions about the utilization of its personnel and material resources, need to be developed.

SYSTEMS ANALYSIS IN EDUCATIONAL PLANNING

Strategic Planning and Operational Control

Efforts to incorporate the principles of strategic planning and operational control into educational planning practices have been encouraging. Pfeiffer (1968), discussing the use of systems approaches in education, recommended the use of system models as a method for identifying and establishing priorities.

A recent review by Chirikos and Wheeler (1968) suggested that the current interest and use of these principles in educational planning have been fruitful. Their study of preliminary data indicated that

since initial systems were primarily concerned with educational outputs, comparatively little research was conducted which would refine the techniques for relating educational inputs to such target outputs. They concluded that this omission has inhibited the maximum production of information relative to decision-making practices and potentials. They indicated, however, that a new method for studying educational planning was being evolved. The older idea of viewing the system in a comprehensive fashion, so as to account for interdependence among the subsystems and ensure internal consistency among system relationships over time, has given way to viewing an educational system as a set of input-output or production relationships which can be controlled in a way that will optimize the use of scarce educational resources.

Homomorphic Models

Although these paradigms have demonstrated the usefulness of systems analysis in educational planning, the operations and activities which characterize strategic planning and operational control are not analogous to those of small research units. Beer (1966), commenting on the appropriateness of systems models, concluded that the best model for revealing the deep identity between the problem situation and the scientific model from which relevant information could be derived is the homomorphic. Homomorphic models represent heuristic methods for inferring the existence and structure of systems whose complexity defeats isomorphic or analogue modeling.

The concepts of management control and management through Program Evaluation and Review Techniques (PERT) seem to be more reflective of

research units' functions. Management control differs from strategies planning and operational control in that it focuses on the whole organization. It is (1) less complex, (2) requires prescriptive procedures, (3) emphasizes both planning and control, (4) has longer time estimates, and (5) controls cost estimates through management practices. Management control, as defined by Anthony (1965), is a process by which managers assure that resources are obtained and used effectively in the accomplishment of the organization's objectives (p. 17).

Cook (1966), discussing the PERT method, defined management as being the art and science of planning, organizing, motivating, and controlling human and material resources and their interactions in order to attain a predetermined objective (p. 3). Planning was operationally defined as the identification of major and subordinate objectives needed to accomplish overall objectives. Organizing consisted not only of the careful definition of program end objectives, but also of the effort involved in determining specific work or tasks and establishing the sequence and dependency existing among the tasks. Controlling, in his terms, is being fully informed of the status of work [situations] on a regular and request basis.

Relevant model. A homomorphic model is being developed at the University of Georgia, College of Education. The Georgia Educational Model (GEM) is being developed from a set of detailed specifications derived from a modification of the systems analysis approach. Johnson, Sharron, and Stauffer (1969), summarizing the procedures used to derive

the specifications, demonstrated that specific objectives and comprehensive source inputs are relevant criteria for the creation of a functional system.

Hypothesis

It is proposed that the most appropriate method for constructing a program budgeting model for small research units would be to systematize those practices which best characterize a unit, following the procedural paradigm used to generate the Georgia Educational Model and employing the principles of management control and PERT.

It is hypothesized that the resultant systems model would provide:

(1) An information system for estimating the critical components involved in the production of a research project and identifying those activities which significantly affect product quality;

(2) Information that would assist in a more effective redistribution of personnel and resources to meet crisis points incurred during the operation of a small research unit;

(3) A method for itemizing costs encumbered during the development and exercution of an educational evaluation;

(4) A method for determining cost estimates for activities which are common to most projects;

(5) A method for estimating personnel, resource, and material costs and activity time expenditures.

PROCEDURES

Phase I: Identifying Within-Unit Activity Characteristics

1. The major activities which occur before, during the preparation, implementation, and completion of a project are summarized and placed on a chart. Only activities which cover interval of one or more weeks are to be included; e.g., conferences with program directors, literature searcher, preparing proposals, conferences with program directors, curriculum specialists, and/or administrative personnel who would be providing relevant inputs into the design, implementation activities, and choice of program participants.

2. Monitoring activities are to be prepared on a separate sheet. When compiling this list, include all activities which are performed during the monitoring sessions: recording observational data; interviewing teachers and pupils; conferring with program/school administrators; preparing interim reports.

When this set of activities is arranged sequentially, it represents a Monitoring Unit (MU). A MU is operationally defined as a collective unit of activities which, over a specified interval of activity or calendar time, can supply the decision-maker with reliable information about the status of a project. Therefore, the number of MU's a project would need is a function of its nature, scope, and objectives. Presumably, some projects could have as few as four (evaluative), whereas others could have as many as twenty (developmental).

3. The activities, identified as major contributors to the execution of an evaluation, are arranged sequentially as a modified Gantt chart where specific research activities are delineated from joint activities (viz., research, administrative, and/or curriculum personnel).

An illustration of a general systems outline constructed around those activities essential for a major project evaluation in the School District of Philadelphia is presented in Figure 1.

Insert Figure 1 about here

A total of 19 major steps is anticipated. Essential activities range from (a) estimating the budgetary requirements of a project to (b) project assignments - conferences where the backgrounds and interests of the research staff are correlated with project requests to produce maximum correspondence between personnel assignments and project specifications.

Phase II: Formulating a Modified PERT Network

When the activity characteristics are converted into specific task specifications, a modified PERT network is formed where time apportionments are a function of the task specifications and the priority of the event. The modified PERT network derived from the essential activities enumerated in Figure 1 is presented in Figure 2.

Insert Figure 2 about here

In this figure, the cluster of events (1-6) shown in the upper-left hand corner represents those events which should be completed prior to implementation of project treatments in the schools. Events 7-18 occur during the regular school year. The Critical Path drawn through the network identifies and standardizes the operational characteristics of the unit. This Critical Path should reflect the maximum time allotments that could be permitted during normal operations of the unit. In this case, eight weeks have been specified for pre-school activities; forty-six weeks for within-school year activities. This arrangement permits an overlap of one week to occur between the completion of previous projects and the decision to continue, modify, or terminate said projects and/or initiate others. However, this overlap occurs during the developmental stages for the insuing school year (pre-school) and not during the active stage of project (within-school).

The small retangular figures appearing above or next to an event represent time approximations, in weeks, for the completion of that event. These time estimates are cumulative. Time differentials between events are derived by subtracting the time estimate of a given event from that of the previous event. Note that two time estimations are made: one, for pre-school activities; the other, for within-school activities. The blank portion of these rectangles are provided for the investigator's approximation of activity time. These judgments of anticipated event times are used to modify time estimates on the next turn-around of projects.

Pre-school year activities. Pre-school year activities are events which must precede the implementation of a project within schools. These

activities would include project assignments, production of project proposals, sample selection, testing and monitoring programs.

Within-school year activities. Within-school year activities are events which are designed to provide information to decision-makers relative to the implementation and realization of project goals and objectives.

Monitoring unit (MU). The activities of a MU is presented in the Interface Activities diagram located in the lower-left hand side of Figure 2. Each MU is terminated by an interim report reflecting the status of the project.

A listing of the activity units documented as critical events of the system is presented in Figure 3.

Insert Figure 3 about here

Research Personnel Activity

The research person who has the primary responsibility for evaluating a given project is presented with the modified PERT network. He is required to place on the PERT network his anticipated completion times for the major events, identified by the rectangular superfigures. Units of activity time are given in weeks (1 week = 1.0). Days, when required, are given in fractions of a week (1 day = 0.2 weeks).

Once the units of activity time are estimated, the researcher accumulates and records his estimated times at each designated point

along the Critical Path. Lag times are present where these summations are less than the stated times. Constraints and/or critical shortages of personnel and resources are evidenced where these summations are greater than the stated times.

PROGRAM BUDGETING TECHNIQUES

Cost Estimating

Estimates of activity unit and project costs are determined by listing the activity events along the Critical Path on the Project Time/Cost Summary Form (Figure 4).

Insert Figure 4 about here

To demonstrate the use of this form, a set of ficticious data is presented for discussion in Figure 5.

Insert Figure 5 about here

1. For each activity those persons who will be involved in the activity are identified. Other would identify resource personnel, i.e., consultants, computer programmer.

2. An estimation of how many actual hours these persons will be involved is entered in the Personnel Time category. Previous information from monitoring reports and the nature of the activity serve as guidelines for these estimations.

3. Using a personnel base rate formula (hours per week X number of weeks/annual wage), approximations of personnel/activity costs are calculated (personnel base rate X hours = personnel cost). All anticipated supportive costs for the activity are placed in the appropriate columns.

Personnel, supportive, and activity costs are obtained by summing across the entries listed for the activity. Any additional information about the activity is placed in the comments section.

4. Monitoring Units (MU) are treated as a single entry. Cost estimates are obtained by itemizing the costs of the events in the MU interface. When this cost is ascertained, it is placed beside activity 11-12 only. If multiples are used (Unit cost of a MU X number of executions), then the total cost is entered, followed by an explanation in the Comments column.

5. Marginal totals of personnel time; personnel, supportive, and activity subtotals are obtained by summing the appropriate columns.

Totals of the personnel, supportive, and activity columns provide (a) subtotals for the two major expenditure categories and (b) an estimate of the operating costs for the project.

Combining the cost estimates of all projects will provide an anticipated operating figure that may be compared with the total monies allocated to the research unit. If reasonable discrepancies exist, initations for budgetary reallocations or additional funds may be sought using the itemized activity cost data as a criterion for such requests.

Cost consumption rates. Consumption rates for the various categories may be approximated by finding budgeted and anticipated cost expenditures per unit interval of time. Budgeted cost expenditure indices may be estimated by obtaining an average budgeted expenditure index (Total monies allocated/number of projects X total operation time in months). Anticipated cost expenditure indices may be derived in a similar manner ($\Sigma\Sigma$project activity expenditures/total operating time in months).

These two indices are plotted as ogives against time. Budget trails or other accounting vouchers of actual monthly expenditures are collected. The differences between the monthly statements are plotted against the two indices to determine whether a budgetary crisis exists or is forecasted. When actual budgetary expenditures exceed the anticipated expenditures, monies are being spent at an excellerated rate such that funds [total or category] will be depleted before the projects are completed. When actual budgetary expenditures are greater than the anticipated expenditures, surplus monies are available for intracategory reallocations.

Personnel utilization rates. A Monthly Project Activity Form (Figure 6) has been developed on which personnel activities may be listed.

Insert Figure 6 about here

This form provides an overall view of the uses of personnel and material

resources. When additional resources are needed to relieve pressure on the system, redistribution decisions, relative to the availability of resources and priority of events, can be made with more certainty and with less debilitory effects on the total operation of the research unit.

CONCLUSIONS

A method for creating a modified PERT network from indigenous operational characteristics of small research units has been proposed to improve management control practices of the research unit.

Adaptations of PERT and management control principles have been generalized across a systems network to produce a simplified method for estimating personnel, materials, resource, and activity costs. Additional methods were proposed for improving management decisions concerning the reallocation of personnel and material resources during stress periods.

IMPLICATIONS

It appears that the proposed techniques could become useful tools in improving the management control practices of small research units on fixed budgets. However, time estimates for activity units remain as the most crucial element in the proposed system. Although weekly time units have been recommended, this module of time could still be too small to encompass the variety of inter- and intraorganizational variations that occur, particularly when dealing with those activities that involve

interpersonal relationships.(viz., joint meetings). Nonetheless, efforts are continually being made to gather data abcut the distribution of time over events. There are indications that better estimates are being made each year.

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A GENERAL SYSTEMS OUTLINE OF THE ESSENTIAL ACTIVITIES ASSOCIATED WITH A MAJOR EDUCATIONAL EVALUATION

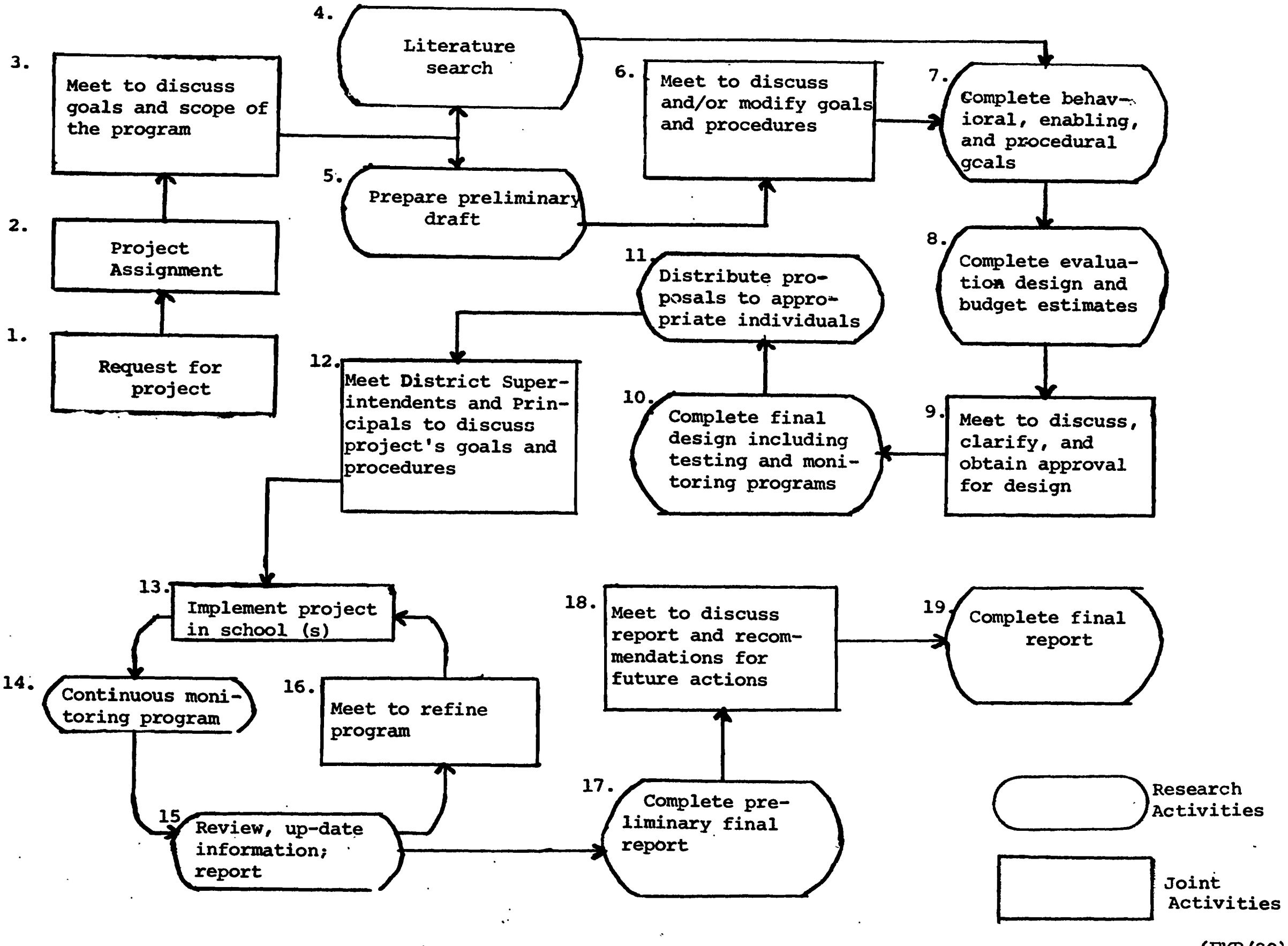

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FIGURE 2

MODIFIED PERT NETWORK FOR MAJOR EDUCATIONAL EVALUATION PROJECTS

Additional Information

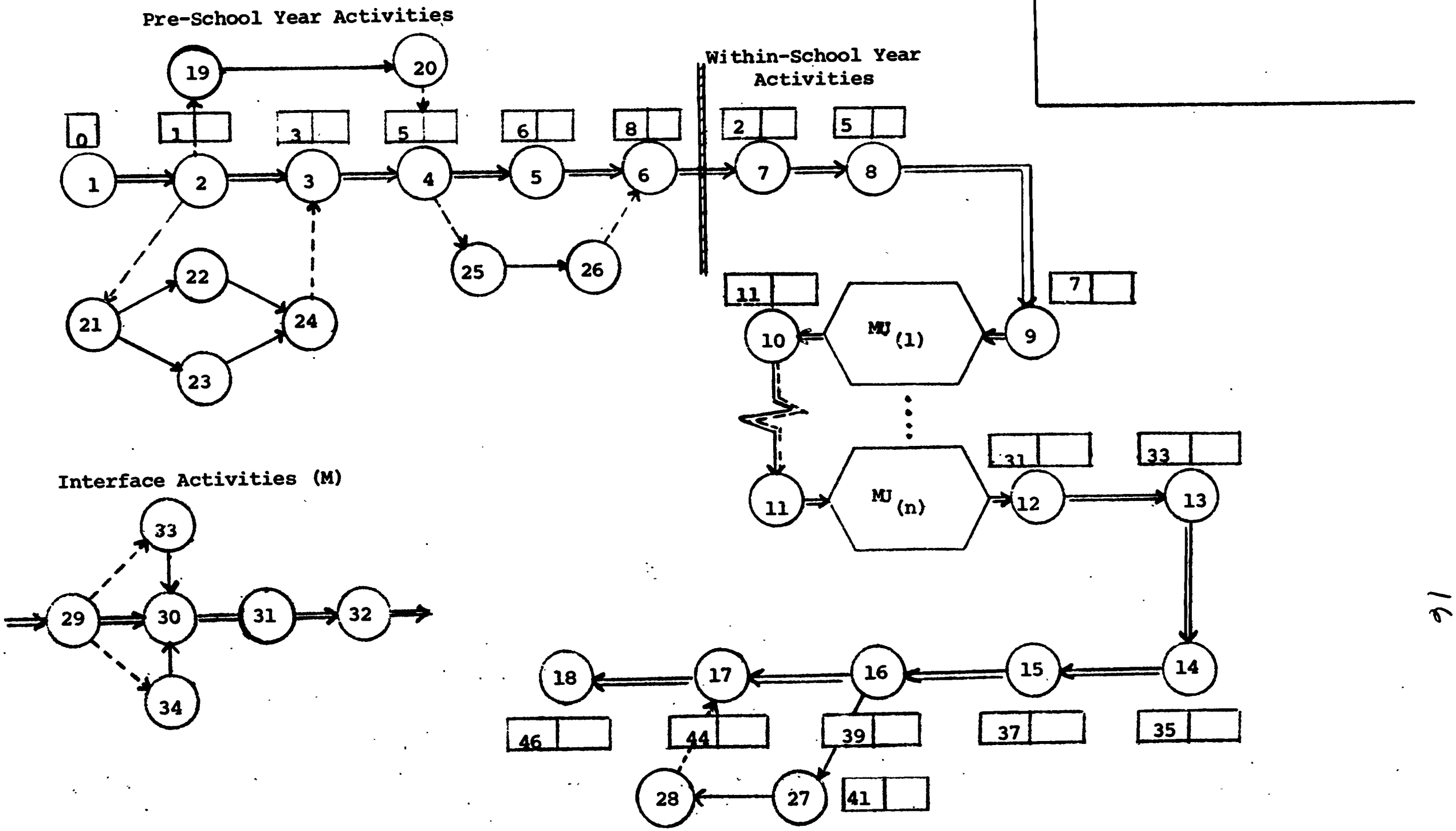

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FIGURE 3

ACTIVITY UNITS

1. Complete review of project request
2. Complete assignment of request
3. Complete preliminary draft of behavioral objectives
4. Complete preliminary draft of proposal
5. Complete sample selection
6. Complete final approved proposal
7. Complete plans for testing and monitoring activities
8. Complete pretesting
9. Begin monitoring activities] MU
10. End monitoring activities
11-12. Monitoring unit (MU)
13. Complete posttesting
14. Complete data gathering
15. Complete data reduction
16. Complete data analysis and interpretation
17. Complete first final report
18. Complete revised final report
19. Begin literature search
20. Complete literature search
21. Begin consultations with project director and curriculum specialists
22. Complete conferences with project director
23. Complete conferences with curriculum specialist
24. Complete consultations with project personnel and curriculum specialists
25. Begin conferences for approval of proposal
26. End conferences with approved proposal
27. Complete report summary
28. Complete reviews of inputs made by reviewers of the report

Interface Activities (MU)

29. Begin monitoring activities
30. Complete observation/monitoring sheets
31. Complete monitoring activity
32. Complete monthly progress report
33. Complete interviews with instructional/administrative personnel
34. Complete interviews with students

PROJECT TIME/COST SUMMARY FORM

CODE	ACTIVITY	UNIT	Personnel Time					Costs								TOTALS			Comments
			1) Director	2) Associate	3) Assistant	4) Secretary	5) Other	Personnel (1)	(2)	(3)	(4)	(5)	Supportive Material	Service	Travel	Personnel	Supportive	Activity	
TOTALS																			

Note: Unit = Estimates from PERT system for total activity time; 1 Unit = 40 hrs.
Personnel Time = Estimates of actual involvement time in hours.

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PROJECT TIME/COST SUMMARY FORM

Fictitious Data

	CODE	ACTIVITY	UNIT	Personnel Time					Costs								TOTALS			Comments [Fictitious Data]
									Personnel					Supportive						
				1) Director	2) Associate	3) Assistant	4) Secretary	5) Other	(1)	(2)	(3)	(4)	(5)	Material	Service	Travel	Personnel	Supportive	Activity	
		1-2	1	3	3	3	2		75	30	23	6					134		134	
		2-3	2	5	25	30	3		125	250	225	9					609		609	
		3-4	2	5	50	30	10	8	125	500	225	30	200			50	1080	50	1130	
		4-5	1		5	5	2			50	38	6					94		94	
		5-6	2	5	20	25	5		125	200	188	15					528		528	
		6-7	2		2	5	3			20	38	9					67		67	Form A
		7-8	2		10	20	8			100	150	24		250	10	20	274	280	554	Read. Comp.(ITBS)
		8-9	2	2	5	10	2		50	50	75	6			5		181	5	186	
*		11-12	20	5	120	165	20		125	1200	1310	60		25	25	50	2695	100	2795	MU X 5
		12-13	2		10	20	8			100	150	24		250	10	20	274	280	554	Read Comp.,ITBS,Form B
		13-14	2		10	20	8	10		100	150	24	25		5	5	299	10	309	
		14-15	2		10	15	8	10		100	112	24	25	50	5		261	55	316	
		15-16	2	2	25	20	10	5	50	250	150	30	25		10		505	10	515	
		16-17	5	10	75	100	50	3	250	750	750	150	15	25	50	10	1915	85	2000	
		17-18	2	3	20	25	5		75	200	188	15			200		478	200	678	
		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
*		29-32	4	1	24	35	4		25	240	262	12		5	5	10	539	20	559	Length of MU
		29-30	2		16	25	1							(5)		(10)				
		30-31	1		4	7	1													
		31-32	1	1	4	3	2								(5)					
	TOTALS		49	40	390	493	144	36	1,000	3,900	3,772	432	290	600	320	155	9,394	1,075	10,469	

Note: Unit = Estimates from PERT system for total activity time; 1 Unit = 40 hrs.
Personnel Time = Estimates of actual involvement time in hours.

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FIGURE 6

MONTHLY PROJECT ACTIVITY FORM

DATES	CODES	Team Activities			Personnel				COMMENTS
		Office	Testing	Monitoring	(2)	(3)	(4)*	(5)	

*Optional

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